UNIVERSITEIT GENT

FACULTY OF BIOSCIENCE ENGINEERING

# Measuring microbial food safety output and comparing self-checking systems of food business operators in Belgium

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## Objective of research ?

Belgian risk management decision in 2003 to :

- introduce 'self-checking system' based on PRPs, HACCP, traceability, notification, legal quality aspects along the agri-food chain
- each food business operator must implement a 'self-checking system'
- certification is possible by commercial third parties or by governmental food safety authority
- certificate ➔ minus on yearly taxes
- **Research question : does the introduction of a self-checking system improve the safety ?**



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## Introduction

**Food Safety Requirements:**
EU Legislation, Belgium legislation, CODEX, PRP/GMP,HACCP, BRC, ISO22000, ...

**Development and implementation of a Food Safety Management System in a specific SME/industrial company in the agri-food chain**

Safe food products ?



## Introduction

EU Research project PathogenCombat (www.pathogencombat.com)

Diagnostic instrument (FSMS-DI) for food processing companies to measure:

- the performance of current FSMS (core control activities and core assurance activities)
- the performance of food safety output
- in relation to the context of a company
- standing apart from auditing/inspection of implemented commercial QA standard/legislation!

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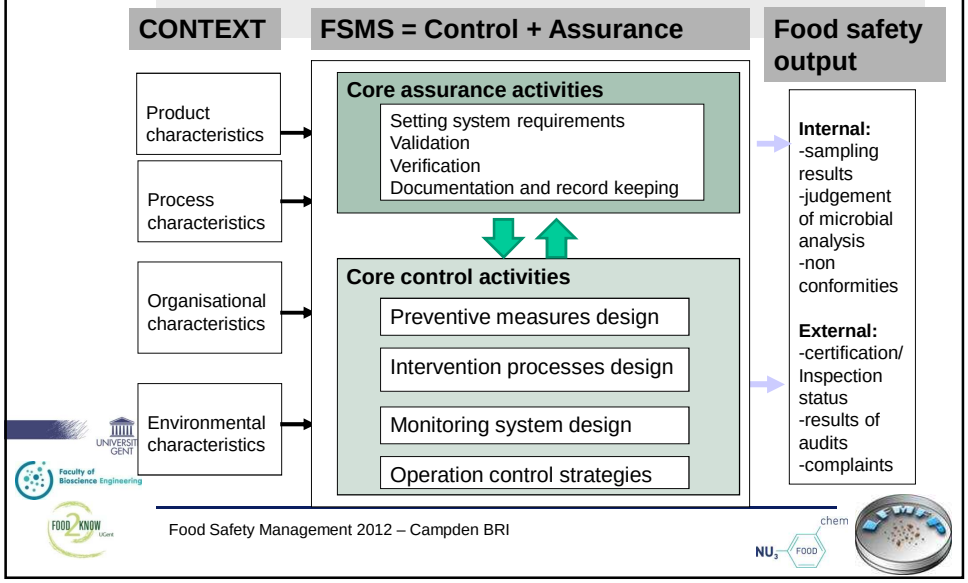
## Introduction



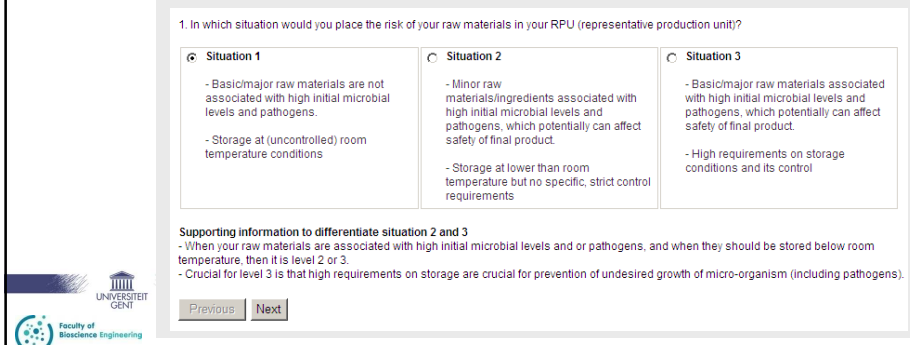

## Introduction

- FSMS-DI – content (58 indicators)

| | | |
|---|---|---|
| **Part I: Introductory section for Food Safety Management System (FSMS)** | | |
| A. | Introduction questions | (1 -11) |
| B. | Selection of Representative Production Unit (RPU) for self-assessment | (12-20) |
| **Part II: assessment of <u>contextual</u> factors** | | |
| A. | Assessment of product characteristics | (A1-3) |
| B. | Assessment of process characteristics | (B4-6) |
| C. | Assessment of organisation characteristics | (C7-13) |
| D. | Assessment of chain environment characteristics | (D14-17) |
| **PART III: assessment of core safety <u>control</u> activities** | | |
| E. | Assessment of preventive measures design | (E18-23) |
| F. | Assessment of intervention processes design | (F24-27) |
| G. | Assessment monitoring system design | (G28-34) |
| H. | Assessment of operation of preventive measures, intervention process and monitoring systems | (H35-41) |
| **PART IV: assessment of core <u>assurance</u> activities** | | |
| I. | Assessment of setting system requirements activities (I42-43) | |
| J. | Assessment validation activities | (J44-46) |
| K | Assessment of verification activities | (K47-48) |
| L | Assessment of documentation and record-keeping to support food assurance | (L49-50) |
| **PART V: assessment of food safety performance** | | |
| M. | EXTERNAL Food Safety Performance | (M51-54) |
| N. | INTERNAL Food Safety Performance | (N55-57) |

# Introduction

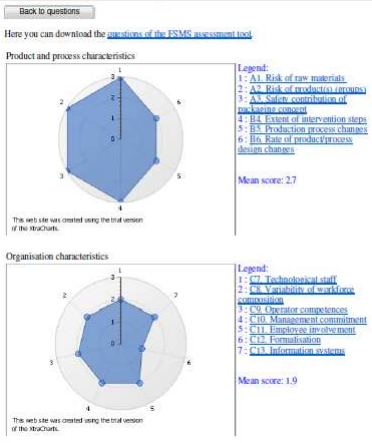
- FSMS-DI – indicators translated into grids






# Introduction

- Indicators are organised in spiderwebs
- Results can be applied as internal audit
- Short/mid/long term improvements of FSMS

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## Introduction

- FSMS-DI:
  - Tool available for PROCESSING FOOD INDUSTRY
  - On line www.pathogencombat.com – on paper
  - Dutch, French, English, Spanish, Greeck
  - Data companies in database of WU
  - Profiling countries – sectors – interventions - …
  - Applied in Belgium study (june 2010 – october 2010)
  - Cooperation FAVV – UGent – WU



## Belgian study

- Quantitative study in Belgian food/feed processing companies
- Different sectors - different size
- With/without certified self checking systems : can we see a difference in level of food safety and level of implemented FSMS ?
  - 200 companies invited ➔ 82 respondents
  - 50% certified for self checking
  - 90% certified for commercial system (BRC, IFS, GMP+, etc)
  - Only 3 companies without any certificate …

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## Belgian study

BIAS in our study …

- ➔ Difficult to get companies involved
- ➔ Involved companies ➔ assumed to have higher level in FSMS due to (multiple) certification
- ➔ Involvement of non certified companies ?

Questions:

- ➔ Can we identify clusters/profiles in FSMS performance in food processing companies in Belgium ?
- ➔ Do we see a difference in level of performance of food safety output (low – moderate – good) ?
- ➔ Do we see a difference in level of performance of actual implemented FSMS (basic – generic – tailored/scientific underpinned) ?



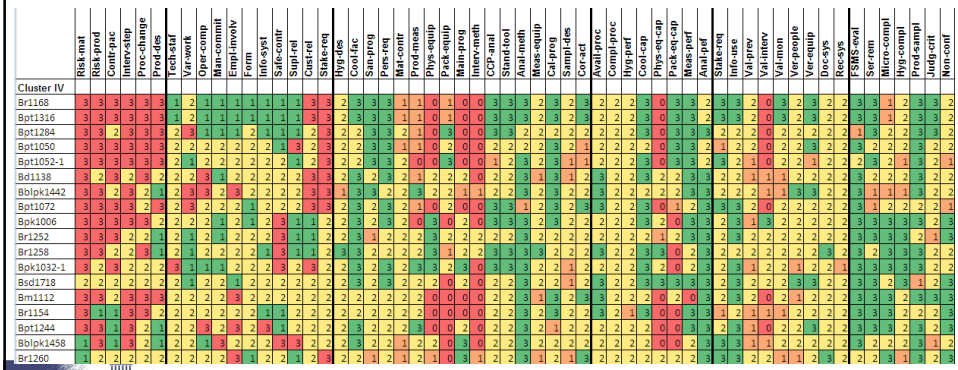
## Characterisation of respondents

n = 41 n = 41

| Production sector | Micro and small (1-9 & 10-49) | | Medium (50-249) | | Large (> 249) | | Total |
|---|---|---|---|---|---|---|---|
| Self checking system | Not certified | Certified | Not certified | Certified | Not certified | Certified | |
| Meat products | 10 | 2 | 2 | 3 | | 2 | 19 |
| Red meat slaughterhouses/cutting | | 3 | | 5 | | | 8 |
| Poultry slaughterhouses/cutting | 2 | | 4 | 2 | 2 | 1 | 11 |
| Ready-to-eat meals | 2 | 2 | 1 | 2 | | | 7 |
| Dairy | | | 3 | 2 | | 1 | 6 |
| Fish processing | 4 | 1 | 1 | | 1 | | 7 |
| Vegetables, fruits, potatoes trade/processing | 2 | 1 | 2 | 3 | | 2 | 10 |
| Industrial bakery | | 1 | 2 | | | 1 | 4 |
| Brewery | | 1 | | 1 | | 1 | 3 |
| Feed | | 2 | | 1 | | | 3 |
| Others | 2 | | 1 | 1 | | | 4 |
| **Total** | **22** | **13** | **16** | **20** | **3** | **8** | **82** |

n = 35 n = 36 n = 11

## Results - database



| Cluster IV | Risk-mat | Risk-prod | Contr-pac | Interv-step | Proc-change | Prod-des | Tech-staf | Var-work | Oper-comp | Man-commit | Empl-involv | Form | Info-syst | Safe-contr | Supl-rel | Cust-rel | Stake-req | Hyg-des | Cool-fac | San-prog | Pers-req | Mat-contr | Prod-meas | Phys-equip | Pack-equip | Main-prog | Interv-meth | CCP-anal | Stand-tool | Anal-meth | Meas-equip | Cal-prog | Sampl-des | Cor-act | Avail-proc | Compl-proc | Hyg-perf | Cool-cap | Phys-eq-cap | Pack-eq-cap | Meas-perf | Anal-pef | Stake-req | Info-use | Val-prev | Val-interv | Val-mon | Ver-people | Ver-equip | Doc-sys | Rec-sys | FSMS-eval | Ser-rem | Micro-compl | Hyg-compl | Prod-sampl | Judg-crit | Non-conf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Br1168 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 0 | 3 | 3 | 2 | 3 | 3 | 2 | 0 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 2 |
| Bpt1316 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 0 | 3 | 3 | 2 | 3 | 3 | 2 | 0 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 2 |
| Bpt1284 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 1 | 0 | 3 | 0 | 0 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 0 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | 3 | 3 | 2 |
| Bpt1050 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 0 | 3 | 3 | 2 | 1 | 2 | 2 | 0 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 |
| Bpt1052-1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 0 | 0 | 3 | 0 | 0 | 1 | 2 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2 | 3 | 0 | 3 | 3 | 2 | 3 | 2 | 1 | 0 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 3 | 2 | 1 |
| Bd1138 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 0 | 2 | 2 | 3 | 1 | 3 | 1 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 |
| Bblpk1442 | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 3 | 2 | 2 |
| Bpt1072 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 0 | 2 | 0 | 0 | 3 | 3 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 0 | 1 | 2 | 3 | 3 | 3 | 2 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 1 |
| Bpk1006 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 2 | 3 | 2 | 0 | 3 | 0 | 2 | 0 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 0 | 3 | 3 | 2 | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| Br1252 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 1 | 3 |
| Br1258 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 0 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 2 |
| Bpk1032-1 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 0 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 0 | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 3 | 2 | 2 |
| Bsd1718 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 0 | 2 | 0 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 2 | 3 |
| Bm1112 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 1 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 0 | 2 | 0 | 3 | 2 | 3 | 2 | 0 | 2 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| Br1154 | 3 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 0 | 0 | 3 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| Bpt1244 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 0 | 0 | 2 | 0 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 3 | 3 | 2 | 3 | 1 | 0 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |
| Bblpk1458 | 1 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 0 | 3 | 0 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 2 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 2 |
| Br1260 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 0 | 3 | 1 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 3 | 2 | 3 |

Etc….



## Results - Food safety output ?

- Overall : moderate (overall score 2) to good (overall score 3) performance of FS output for all Belgian food/feed processing companies

| n | Overall score for food safety output |
|---|---|
| 15 (18%) | Good |
| 57 (70%) | Moderate-good |
| 9 (11%) | Moderate |
| 1 (±1%) | Moderate-low |

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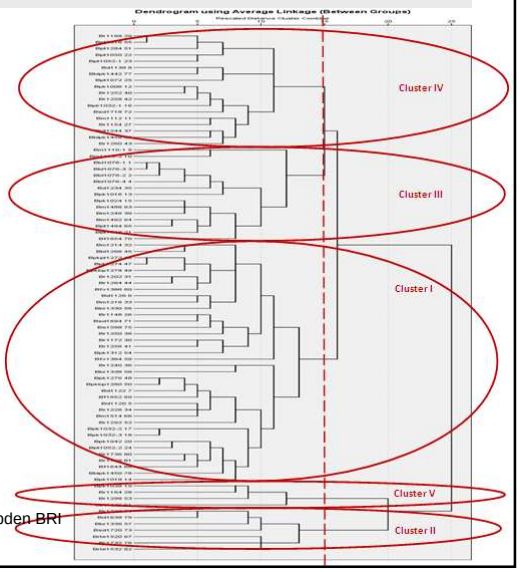
## Results - Clusters ?

- Individual database
- Hierarchical cluster analysis
- Dendograms
- 5 clusters could be defined






## Results - identification of clusters

73% of all companies and 76% certified SC

| Cluster | Number of companies | % certified for self checking | Sector |
|---|---|---|---|
| Cluster I | 38 | 60 | Animal products |
| Cluster II | 7 | 71 | Non animal products (FVP, candies, brewery, feed, bakery) |
| Cluster III | 15 | 20 | Animal products |
| Cluster IV | 18 | 44 | Mixture of companies but no intervention possible in process |
| Cluster V | 4 | 50 | Mixture |

Overall performance

## Results – Cluster I versus III

Cluster I: 97 % commercial 60 % self checking

Cluster III: 90 % commercial 20 % self checking


- Cluster I and Cluster III : all animal products



## Results – Cluster I versus III


- Cluster III less advanced FSMS compared to cluster I

## Belgian results in the European context

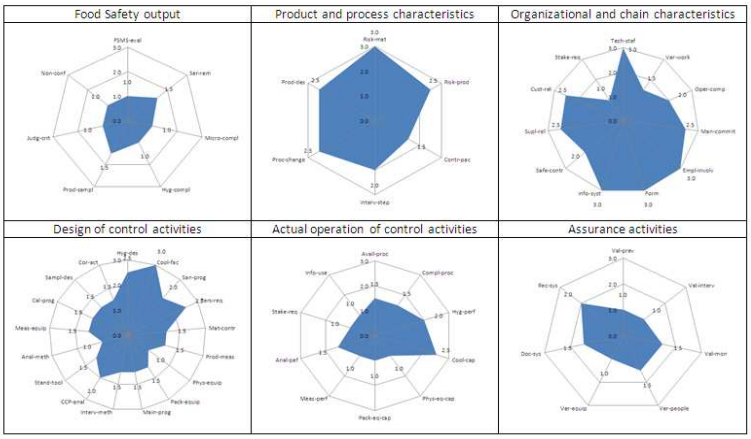
- Survey also conducted in Spain, Greece, the Netherlands
- Outside Europe e.g. Japan

- Differences with Belgium ?
  - Lower food safety output ➔ internal evaluation of food safety output (e.g. product sampling, judgement criteria, non conformities) ➔ more severe internal judgement by Belgian companies
  - Core assurance activities (validation and verification) ➔ elaborated at higher level in Belgian companies
  - Belgian companies high level of performance of FSMS (more advanced, tailored and scientific underpinned)
  - Awareness of importance of food safety and FSMS ?
  - Drive of legislation / self checking systems ?



## Belgian results in the European context

- Example of lowest cluster in European study (no Belgian companies…)



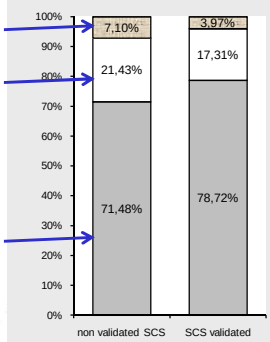
## Improvement of FSMS by introduction self checking system ?

- Evolution of official inspection results conducted by government (Belgian FASFC)

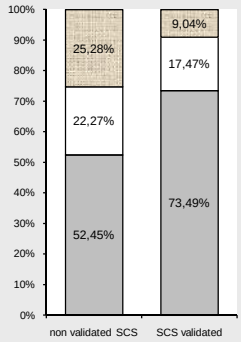
No acceptable inspection results

Acceptable inspection results with remarks

Acceptable inspection results




**Transformation sector**




**Distribution sector**



## Conclusions

- Overall Belgian food processing companies demonstrated good performance of food safety output and rather advanced level of food safety management systems
- Validation and verification activities in a FSMS are less advanced worked out
- Impact of introduction of self checking systems was more difficult to see in transformation sector due the the high presence of voluntary standards and certification

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## Conclusions

- To be continued…
- Current running FP7 project 'Veg-i-Trade'

  - Extended to other actors in the chain (e.g. primary production, trade sector)
  - Context ➔ aspect of globalisation will be included
  - Focus also on mycotoxins and pesticide residues next to microbial hazards
  - Veg-i-Trade
    - www.veg-i-trade.org


Impact of Climate Change and Globalisation on Safety of Fresh Produce

Governing a Supply Chain of Uncompromised Food Sovereignty



## Acknowledgements


- FAVV : Jacques Inghelram, Herman Diricks
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- UGent : Mieke Uyttendaele
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